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H4B BK16D

(56) Documents Cited
GB 2249682 A GB 2236895 A EP 0408394 A1
WO 92/09150 A1 WO 91/09475 A1 WO 87/04881 A1

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UK CL (Edition L) H4B BK16D
INT CL[5] H04B

(54) Optical transmission system

(57) An optical fibre cable, e.g. for a submarine transmission system incorporates a length of amplifying fibre 231 spliced into a transmission fibre 23a whereby to amplify transmitted signals. Optical pump power for the amplifying fibre is supplied from one end of the cable via a further fibre 232 and a coupler 24. In another embodiment, the pump power may be supplied along the transmission fibre.

FIG.2

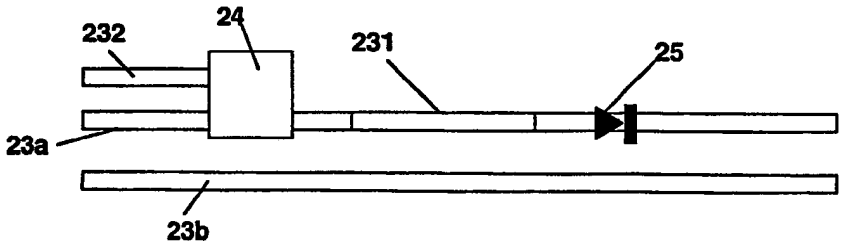

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FIG.1

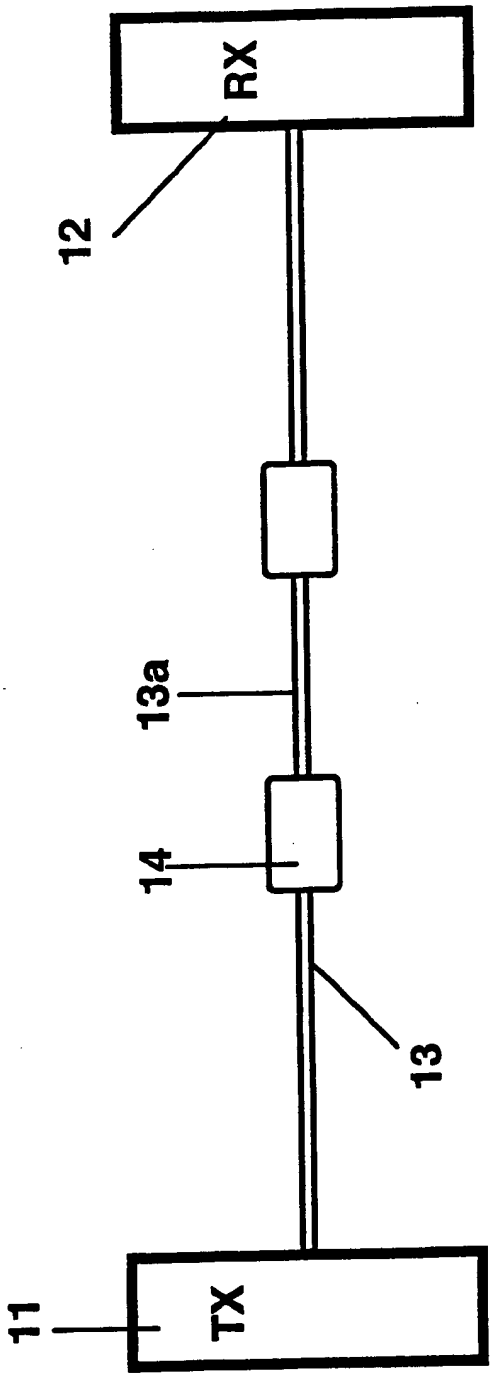


FIG.2

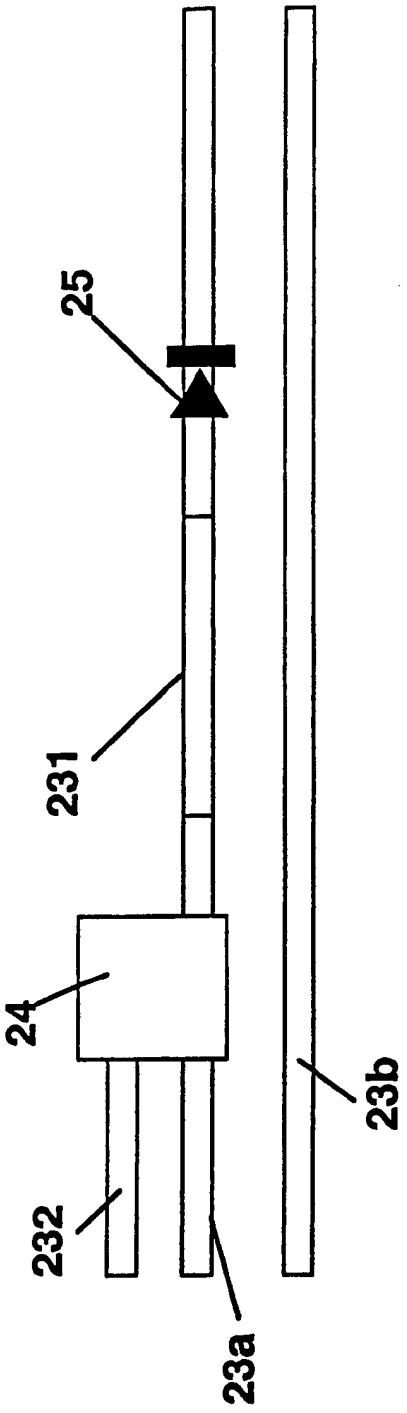


FIG.3

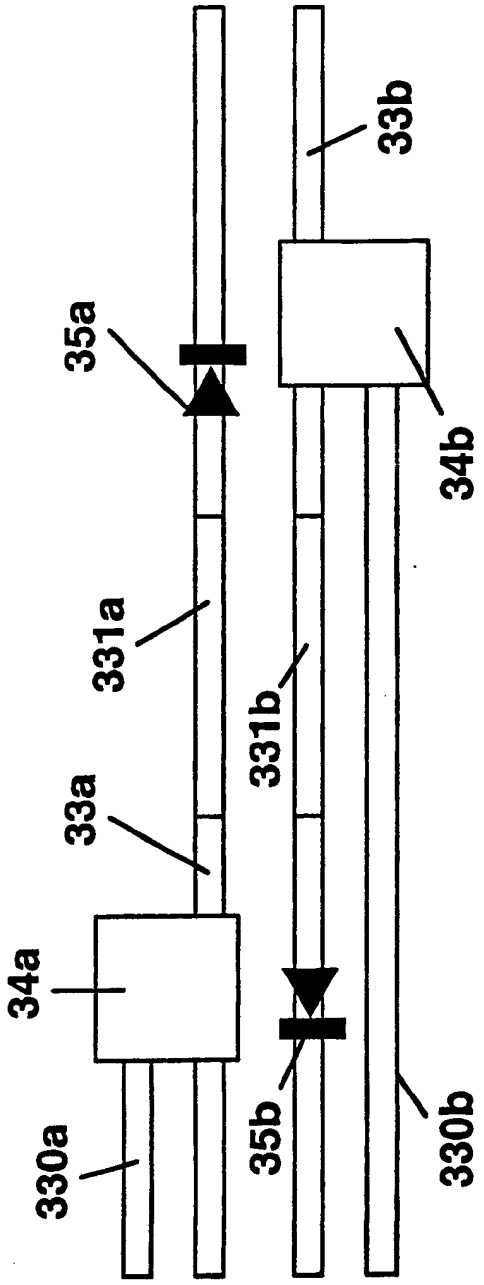


FIG.4

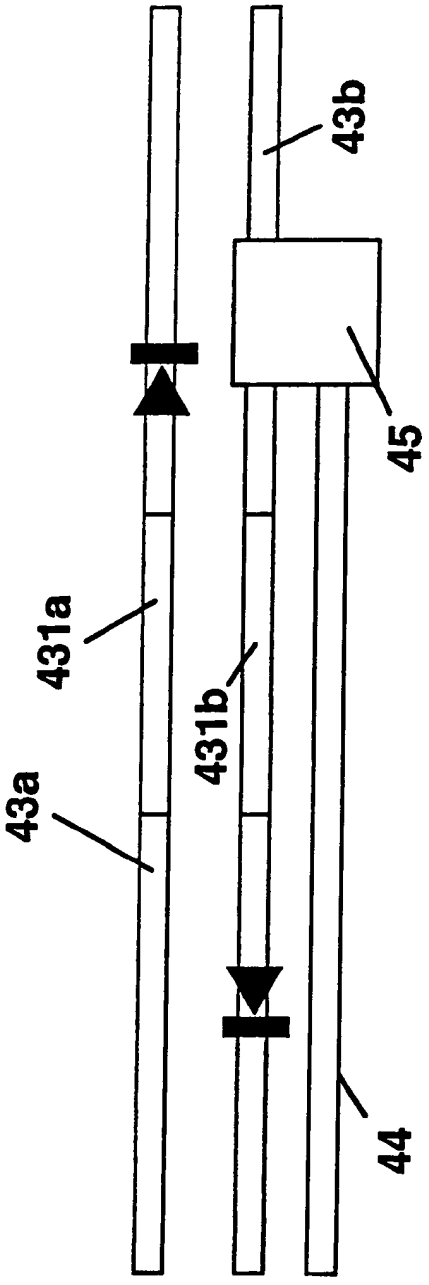
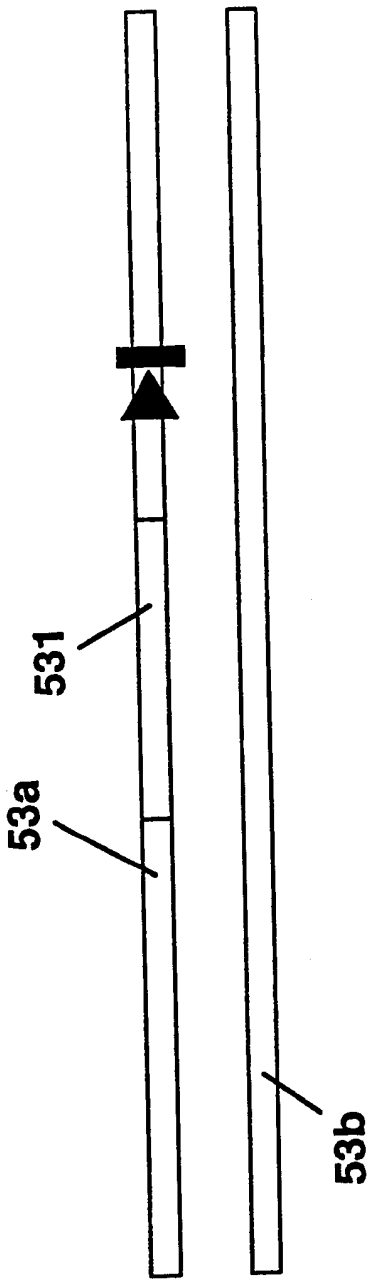


FIG.5



OPTICAL TRANSMISSION SYSTEM

This invention relates to optical transmission systems, e.g. for submarine applications.

Lightweight submarine cables have recently been introduced for relatively short haul applications in which optical signals are transmitted along the cable without regeneration. These cables have the big advantage of low cost in comparison with a conventional submarine cable.

Improvements both in optical fibre technology and in optoelectronic technology have extended the span length for which an unrepeatered cable may be employed. However, it is now considered that any further increase in unrepeatered span length at an acceptable cost is unlikely. To overcome this limitation, various workers have considered the provision of one or more repeaters in a cable of this type. Such a solution has not proved practical as it has been found that the cable has insufficient strength to support a conventional massive repeater housing during cable laying/recovery operations in deep water. Also, the cost of a conventional submarine repeater is a significant item in the overall system cost. There is also the problem of supplying the repeater with electrical power along the cable.

The object of the invention is to minimise or to overcome this disadvantage.

According to one aspect of the invention there is provided an optical transmission system including a transmitter, a receiver, and an optical fibre path comprising a cable therebetween, wherein said cable incorporates at least one optical amplifier for amplifying transmitted signals, and wherein the cable incorporates means for transmitting optical pump power for the amplifier from the transmitter and/or the receiver.

According to another aspect of the invention there is provided an optical fibre cable incorporating at least one optical amplifier, the cable having means for transmitting optical power to the amplifier from one or from both ends of the cable.

Embodiments of the invention will now be described with reference to the accompanying drawings in which:-

Fig. 1 is a schematic diagram of an optical transmission system; and

Figs. 2 to 5 illustrate various cable constructions for use in the transmission system of Fig. 1.

Referring to Fig. 1, the transmission system includes a transmitter station 11, a receiver station 12 and an optical fibre path comprising a cable 13, e.g. a submarine cable, therebetween.

The cable 13 incorporates at least one amplifying section 13a disposed in the cable between a pair of cable joints 14. Typically this amplifying section 13a incorporates a length, e.g. about 20m, of erbium doped fibre and is spliced into the cable 13 between the two joints. As the amplifying fibre is thus formed into the cable rather than being disposed in a repeater housing, it is protected from moisture and hydrogen ingress. The amplifying fibre may be incorporated in a length of similarly constructed cable which is spliced between the two joints.

Optical pump power for the amplifying section 13a of the cable 13 is supplied from one or both ends of the cable via the transmitter 11 and/or the receiver 12. There is thus no need for any provision of electrical power within the cable.

Fig. 2 illustrates one form of cable construction for use in the system of Fig. 1. The cable incorporates transmission fibres 23a, 23b, e.g. for forward and return transmission, and into one of which a length of erbium doped amplifying fibre 231 is spliced. Pump power from the amplifying fibre 231 is supplied, e.g. from the transmitter end of the system via a further fibre 232 and a coupler 24. An optical isolator 25 may be provided to suppress backward reflections.

Fig. 3 shows an arrangement in which pumping of both forward (33a) and return (33b) fibre paths is effected from one end of the system, e.g. the transmitter station, via respective pump fibres 330a and 330b. These latter fibres couple pump power via couplers 34a and 34b to amplifying fibre sections 331a and 331b respectively. Backward reflections may be suppressed by isolators 35a and 35b.

Fig. 4 shows an arrangement in which two-way amplification is achieved using a common fibre 43a for both the forward signal and the pump power for the forward path. The fibre 43a incorporates an amplifying section of erbium fibre 431a. The return signal is carried on a further fibre 43b incorporating an amplifying section of erbium fibre 431b, this section being pumped from the transmitter end via a fibre 44 and coupler 45.

Fig. 5 shows a system which provides one way amplification e.g. of the forward path from the transmitter end. A similar arrangement (not shown) may be incorporated to provide amplification of the return path comprising fibre 53b from the receiver end. In this arrangement the forward path fibre 53a incorporates an amplifying section 531 provided with pump power via the forward path fibre itself.

Although the above technique has been described with particular reference to submarine transmission systems, it will of course be appreciated that it is equally applicable to landline systems where it may be desirable to provide a remotely powered amplifying facility in an inaccessible region.

CLAIMS

1. An optical transmission system including a transmitter, a receiver, and an optical fibre path comprising a cable therebetween, wherein said cable incorporates at least one optical amplifier for amplifying transmitted signals, and wherein the cable incorporates means for transmitting optical pump power for the amplifier from the transmitter and/or the receiver.

2. An optical transmission system as claimed in claim 1, wherein said amplifying means comprises a length of amplifying fibre spliced into a signal carrying fibre of said cable.

3. An optical transmission system as claimed in claim 2, wherein said amplifying fibre is incorporated in a cable section spliced into the cable between a pair of cable joints.

4. An optical transmission system as claimed in claim 2 or 3, wherein the amplifying fibre is, in use, provided with pump power via the signal carrying fibre.

5. An optical transmission system as claimed in claim 3 or 4, wherein an optical isolator is provided adjacent the amplifying fibre whereby to suppress backward reflections.

6. An optical transmission system substantially as described herein with reference to and as shown in Fig. 1 together with any one of Figs. 2 to 5 of the accompanying drawings.

7. An optical fibre cable incorporating at least one optical amplifier, the cable having means for transmitting optical power to the amplifier from one or from both ends of the cable.

8. An optical fibre cable as claimed in claim 7, wherein the amplifier comprises a section of amplifying fibre spliced into a signal carrying fibre of said cable.

9. An optical fibre cable as claimed in claim 8, wherein the amplifying fibre is incorporated in a cable section spliced into the cable between a pair of cable joints.

10. An optical fibre cable as claimed in claim 8 or 9, wherein the amplifying fibre is, in use, provided with pump power via the signal carrying fibre.

11. An optical fibre cable substantially as described herein with reference to and as shown in Fig. 2, 3, or 5 of the accompanying drawings.

Patents Act 1977 Examiner's report to the Comptroller under Section 17 (The Search report)	Application number GB 9317516.4
Relevant Technical Fields (i) UK Cl (Ed.L) H4B (BK16D) (ii) Int Cl (Ed.5) H04B	Search Examiner DR E PLUMMER Date of completion of Search 21 OCTOBER 1993
Databases (see below) (i) UK Patent Office collections of GB, EP, WO and US patent specifications. (ii)	Documents considered relevant following a search in respect of Claims :- 1 AT LEAST

Categories of documents

X: Document indicating lack of novelty or of inventive step.

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A: Document indicating technological background and/or state of the art.

P: Document published on or after the declared priority date but before the filing date of the present application.

E: Patent document published on or after, but with priority date earlier than, the filing date of the present application.

&: Member of the same patent family; corresponding document.

Category	Identity of document and relevant passages		Relevant to claim(s)
X	GB 2249682 A	(NORTHERN TELECOM) eg Figure 1, abstract	1, 6, 7, 11
X	GB 2236895 A	(BRITISH TELECOM) eg Figure 1, page 1 line 27 - page 2 line 1	1, 2, 6, 7, 8, 11
X	EP 0408394 A1	(BRITISH TELECOM) eg abstract, Figure 1	1-11
X	WO 92/09150 A1	(BRITISH TELECOM) eg abstract, Figure 1	1-11
X	WO 91/09475 A1	(BRITISH TELECOM) eg Figure 1, Figure 2, abstract	1, 2, 3, 6, 7, 8, 9, 11
X	WO 87/04881 A1	(ADVANCED LASERS) eg Figure 5, page 5 lines 7-10	1, 2, 3, 6, 7, 8, 9, 11

Databases: The UK Patent Office database comprises classified collections of GB, EP, WO and US patent specifications as outlined periodically in the Official Journal (Patents). The on-line databases considered for search are also listed periodically in the Official Journal (Patents).